RAILWAY BEACON AND RELATED PRODUCTION METHOD

TECHNICAL FIELD

The present invention relates to a railway beacon (balise), and to a method of producing a railway beacon (balise).

BACKGROUND ART

Railway beacons (also known by the French term "balise") are known which are laid along a railway line, and each comprise a casing supporting an electronic circuit, which receives an electromagnetic enabling signal from a vehicle travelling along the railway line, and generates a coded response signal (telegram) transmitted to the vehicle and containing information relative to the location and travel of the vehicle.

Beacons of this sort also comprise a receiving antenna and a transmitting antenna, both carried by the casing and cooperating with the electronic circuit to receive/transmit electromagnetic signals from/to the vehicle.

The beacons are laid between the rails of the

railway line, and are anchored to the sleepers by means of a kit ensuring firm attachment to the railway line. As such, the beacons are exposed to various external agents which may damage the beacon itself and/or the electronic circuit inside.

Such external agents include:

- atmospheric agents (steam, rain, ice and snow) to which the beacon is exposed;

- mechanical stress on the beacon, such as vibration produced by passing vehicles, or thermal stress caused by heating/cooling of the beacon;

- chemical agents (acid, oil, powdered carbon, sulphur, iron, zinc, etc.) to which the beacon is exposed; and

- interaction of the beacon with parts of the railway line, in particular the ballast forming the base of the railway line and which may at least partly cover the beacon.

DISCLOSURE OF INVENTION

It is an object of the present invention to provide a beacon which is particularly resistant to external agents, in particular, steam, water, ice and snow.

According to the present invention, there is provided a railway beacon designed for laying along a railway line and comprising: a casing supporting at least one electronic circuit, which receives an electromagnetic enabling signal from a vehicle

travelling along the railway line, and generates a coded response signal (telegram) transmitted to the vehicle and containing information relative to travel of the vehicle; and a receiving antenna and a transmitting antenna, both carried by said casing and cooperating with said electronic circuit; **characterized in that** said casing is formed in one piece from insulating material; said casing having at least one sunken seat housing at least one printed circuit defining said electronic circuit; said sunken seat being filled with solidified insulating resin embedding said printed circuit and the electronic components on the printed circuit; and said insulating resin containing no air, in particular no air bubbles, and comprising no water in its composition.

The present invention also relates to a method of producing a railway beacon, characterized by comprising the steps of: producing a casing made of insulating material and having at least one sunken seat; inserting an electronic circuit, formed on at least one support, in particular a printed circuit, inside said sunken seat, said electronic circuit receiving an electromagnetic enabling signal from a vehicle travelling along a railway line, and generating a coded response signal (telegram) transmitted to the vehicle and containing information relative to travel of the vehicle; producing a resin containing substantially no water particles or air; feeding said resin inside said

sunken seat, so as to embed said support and the components on said support inside said resin, and allowing the resin to set to obtain a stable position of said electronic circuit inside said casing.

BRIEF DESCRIPTION OF THE DRAWINGS

A preferred, non-limiting embodiment of the invention will be described by way of example with reference to the accompanying drawings, in which:

Figure 1 shows a view in perspective of a beacon in accordance with the teachings of the present invention;

Figure 2 shows a view in perspective of a component part (antenna) of the Figure 1 beacon;

Figures 3a-3g show successive steps in the manufacture of the beacon using the method according to the present invention.

BEST MODE FOR CARRYING OUT THE INVENTION

With particular reference to Figure 1, the beacon 1 comprises an insulating casing 3 for supporting an electronic circuit 4, and for housing electronic circuit 4 in airtight manner inside beacon 1.

Beacon 1 is located between the rails of a railway line, and is fixed to the sleepers by means of an assembly kit (not shown).

Electronic circuit 4 receives an electromagnetic enabling signal from a vehicle travelling along the railway line, and generates in known manner a coded response signal (telegram) transmitted to the vehicle

and containing information relative to the location and travel of the vehicle.

More specifically, casing 3 is formed in one piece from synthetic insulating material, and is in the form of a parallelepiped-shaped plate bounded on opposite sides by a flat rectangular bottom face 3a (shown facing upwards in Figure 1 but in actual use facing downwards), and by a flat rectangular top face 3b.

Casing 3 is bounded laterally by a number of adjacent flat rectangular walls 9, 10, 11, 12 perpendicular to one another, and comprises a number of sunken, parallelepiped-shaped seats 12a, 12b, 12c, 12d (four in the example shown, but which may be any number) which open out at bottom face 3a and are arranged substantially symmetrically with respect to an axis 13 perpendicular to casing 3 and through a central portion of casing 3. Each parallelepiped-shaped seat 12 is bounded by a substantially flat rectangular bottom wall 15, and by four flat rectangular lateral walls 16.

At least one sunken seat 12a comprises, at the opening 19 at which seat 12a opens out at bottom face 3a, a sunken annular edge 20 extending along the end portions of lateral walls 16; and a flat rectangular cover plate 22 is positioned with its peripheral edges 22a resting along annular edge 20 to close opening 19 in fluidtight manner.

Two adjacent seats 12a, 12b are separated by a

partition 24 fitted with a through connector 26 having a first end 26a facing sunken seat 12a, and a second end 26b facing seat 12b.

Electronic circuit 4 is defined by a number of electronic components 33 (integrated circuits, transistors, resistors, capacitors, inductors, transformers, etc.) mounted on a printed circuit 38 for supporting and electrically connecting components 33 in known manner. According to the present invention, electronic circuit 4 is housed inside sunken seat 12a, and is seated firmly inside the seat by means of a hardened silicone resin 40 embedding printed circuit 38 and electronic components 33.

More specifically, the hardened silicone resin 40 has the following characteristics:

- is of insulating type (with a resistivity of about 7.1 10^{13} Ω/cm);

- contains substantially no air particles (e.g. micro air bubbles) and has a dielectric strength of 16.5 kV/mm;

- contains substantially no water particles, i.e. contains substantially no water in its composition (has a water content of less than 0.1%).

According to a particular aspect of the present invention, a receiving antenna 42 and a transmitting antenna 44, both formed on the same annular support and connected to electronic circuit 4, are co-molded

directly inside lateral walls 9, 10, 11, 12.

Receiving antenna 42 and transmitting antenna 44 comprise a supporting structure 50 (Figure 2) defined by four adjacent elongated rectangular printed circuits 52a, 52b, 52c, 52d forming a rectangular frame structure. More specifically, adjacent printed circuits 52 are connected electrically and mechanically by L-shaped arcs 54 of conducting wire (e.g. copper) extending between adjacent end portions of printed circuits 52.

Each printed circuit 52 comprises a first number of copper tracks 55 connected by L-shaped arcs 54 to respective first numbers of copper tracks on the other printed circuits 52 to form, as a whole, receiving antenna 42.

Each printed circuit 52 also comprises a second number of copper tracks 56 connected by L-shaped arcs 54 to respective second numbers of copper tracks on the other printed circuits 52 to form, as a whole, transmitting antenna 44. And each rectangular printed circuit 52a, 52b, 52c, 52d is co-molded and embedded inside a relative flat rectangular wall 9, 10, 11, 12.

Electric conductors 60 extend through a through conduit 32 to connect receiving antenna 42 and transmitting antenna 44 to electronic circuit 4.

Figures 3a-3g show, schematically, the method of producing the beacon according to the present invention.

For this purpose, a mold 70 (Figure 3a) may be used comprising a top half-mold 70a and a bottom half-mold 70b, preferably made of metal (e.g. stainless steel).

Half-molds 70a, 70b are closed (Figure 3b) to form a cavity 72 complementary in shape to casing 3.

The supporting structure of antennas 42, 43 is also inserted inside cavity 72.

A mixture of heat-setting materials containing a predetermined quantity of glass fibre is then injected into cavity 72.

The mixture containing the glass fibre is allowed to set and polymerize completely (half-molds 70a and 70b may be fitted with heating resistors to speed up the process), and half-molds 70a and 70b are then opened to remove casing 3 (Figure 3c) which, so formed, comprises sunken seats 12a-12d and incorporates antennas 42 and 44.

Casing 3 may then be coated with an insulating gel-coat 74 (Figure 3c), which is sprayed onto all the outer surfaces of the casing, and coats lateral walls 9, 10, 11, 12, bottom face 3a, top face 3b, bottom walls 15, and lateral walls 16. Printed circuit 38 (Figure 3d) is then placed inside sunken seat 12a, and is connected electrically to receiving antenna 42, transmitting antenna 44, and through connector 26. Printed circuit 38 is connected to antennas 42, 44 using braided cables extending in fluidtight manner through wall 10.

Resin 40 (Figure 3e) is then poured into sunken seat 12a. The resin may preferably be a silicone resin comprising two liquid components (A and B), which are mixed and then treated in known manner to eliminate air particles and any water molecules from the mixture. Alternatively, each component (A and B) may be treated in known manner to eliminate air particles and any water molecules in the component; and the components are then mixed to form resin 40.

The resin may be poured as follows:

- a nozzle 77 is placed close to printed circuit 38 and bottom wall 15 of the sunken seat (Figure 3e), so that the poured resin 40 covers the whole of bottom wall 15, contacts a bottom face 38a of printed circuit 38, and then covers a top face 38b of printed circuit 38; when pouring the resin, nozzle 77 is preferably located on the opposite side to through connector 26, and pour speed is controlled to prevent the formation of air bubbles;

- nozzle 77 (Figure 3f) is then moved into position close to the larger components (e.g. transformers, inductors, connectors) on printed circuit 38, and resin 40 is poured so as to expel any air beneath and/or inside the components;

- pouring of resin 40 continues until sunken seat 12a is filled completely with resin 40; at which point, casing 3 is transferred slowly and at controlled speed

(so as not to disturb the resin) to a storage station (not shown) where resin 40 is allowed to set hard.

Manufacture of beacon 1 is completed by applying cover plate 22.

Tests conducted by the Applicant show beacon 1 to be highly resistant to external agents, in particular water, damp (steam), snow and ice, and undergoes no deterioration in electric characteristics. Electronic circuit 4 and the parts connected to it (antennas 42, 44 and connector 26), in fact, are enclosed in resin 40 or casing 3, which prevent any external agents contacting electronic circuit 4. In addition, the solidified resin 40 itself contains no elements (air or water) capable of eventually oxidizing the printed circuit tracks or connector 26 and/or affecting performance of the electronic components on the printed circuit.